AMERICAN LIFE TABLES.

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The purpose of this paper is to present the first mortality tables ever constructed in this country, based on population data and mortality statistics covering as many as ten years. The methods used in their construction is also briefly explained.

Three mortality tables are given: one for the males, one for the females, and one for males and females combined, and all are based on data covering the decade 1901–1910.

The decade 1901–1910 represents the first period in which mortality statistics were collected and published annually by the government, previous reports having been made decennially. Other countries—such as England, Germany and France—have not only been collecting and publishing mortality statistics annually for many decades but have constructed appropriate mortality tables exhibiting the death-rates, expectations of life, etc., at each age. This country is far behind the most prominent countries in this respect, less than half of the total number of the states being compelled at present to keep any accurate record of deaths.

However, the work of the government in the collection of mortality statistics is exceedingly worthy of commendation considering how recent the main part of the work was begun (1880) and the strides made in those years, particularly the last decade.

The data used in this paper were collected from those states whose records are considered sufficiently accurate by the government to be designated formally as registration states.* These registration states, together with about one hundred and fifty cities in non-registration states, comprise the so-called registration area proper.

In 1900 the registration states included Connecticut, Indiana, Maine, Massachusetts, Michigan, New Hampshire, New Jersey, New York, Rhode Island, Vermont, and the District of Columbia. In 1906 there were added the states California, Colorado, Maryland, Pennsylvania, and South

* See Bulletin 104, Mortality Statistics, 1908, p. 7.

Dakota, although South Dakota's report was rejected in 1910. Washington and Wisconsin were added in 1908, Ohio in 1909, and Minnesota, Montana, and Utah in 1910.

As the population data are collected only once in each ten years, they were assumed to change from year to year by a constant difference.

It was taken into consideration that the census for 1900 was taken as of June 1 and that for 1910 as of April 15. For example, the population at June 1, 1901, was taken as the population at June 1, 1900, plus 6-79 of the difference between the populations at June 1, 1900 and April 15, 1910.

The population at January 1 for any year was found by adding to the population at June 1 (or April 15) 5-12 (or 7-24) of the deaths for that year, on the assumption that deaths take place uniformly throughout the year.

The total data used covered not only the eleven original registration states (as of 1900) but all that became registration states during the decade 1901–1910. Thus twenty-two states were included. North Carolina was not included because the appropriate population data were not available by ages (being wholly urban).

The mortality statistics are given in quinquennial age groups, except at the earlier ages from 0 to 4 inclusive, at which the deaths are given for each age.

The population data are given in quinquennial age groups except at the higher ages beginning with age 65 at which the data are given in decennial age groups.

The decennial age groups were broken up into quinquennial age groups by ordinary third differences and the quinquennial age groups, both for population and mortality data, were broken up into data for each age by first forming columns of T_x from each set of data, where T_x represents the number (deaths or population) at age x and all higher ages, and interpolating the four intervening values for each group—except, of course, the two at each end—by Sprague's Osculatory method.* This method cannot be explained here, as space will not permit. We merely state that the method has the advantage over the use of ordinary fifth differences in that

* The Record, American Institute of Actuaries, Vol. I, No. 3, June, 1911, p. 9.

the curvature as well as the slope of the curve, representing
the values under discussion, is considered, with the result that
the curve, which would otherwise be somewhat "undulating,"
becomes very smooth throughout.

The two quinquennial age groups at each end were inter-
polated by ordinary third differences (taken centrally in the
case of the inner groups).

The first quinquennial age group of the population data,
however, was an exception, because use was made of the
population as given for those at the age of birth.   The values
used as a basis for interpolation being no longer equidistant—
as is necessary in the use of ordinarry differences—La Grange's
interpolation formula was used to obtain the population at
ages 2, 3, and 4.

The work of constructing mortality tables (such as are
presented in this paper) would be much easier if the census
would include tables of populations for the different divisions
of the registration area as given in the mortality statistics,
this area being the only area of any value for such purposes.
The conflicting definitions of "urban" and "rural" population
used by the census and in the mortality statistics is also un-
fortunate and could be easily remedied.

The death-rates in the neighborhood of age 90 are doubt-
lessly so unreliable that refined methods of extending the
tables beyond that age are not worth while.   However, for
the purpose of computing the expectation of life (a function
little affected by choice of methods of terminating the mortal-
ity tables) for each age, the tables were completed by using
ordinary third differences, as applied to the death-rates at
ages 70, 75, 80 and 85, to estimate the death-rates at higher
quinquennial ages.   The intervening death-rates were inter-
polated by Sprague's method mentioned above.

In conclusion, tables are given comparing the death-rates
and expectations of life at representative ages of the American
mortality tables, presented in this paper, with those of similar
tables constructed in England and Wales,* and the German
Empire.*   However, it must be kept in mind that the latter

* Sixty-fifth Annual Report of the Registrar-General.   Supplement 1891–1900, Part I, p. xlii.
* Deutsche Sterbetafeln 1891–1900.   Band 200, Seite 2.

tables are based on data covering the decade 1891–1900 while the American tables refer to the decade 1901–1910.

The English and German death-rates exceed the American rates everywhere except in the neighborhood of ages 10 and 20, and even here there is no essential difference. The American death-rates are relatively very low at the age of birth, the German rates seeming very excessive.

As might be expected, on considering the table of representative death-rates, the American expectations of life far exceed those of England and Wales, and the German Empire, the average length of life in America being about 50 years, compared with about 46 years in England and Wales, and about 42 years in the German Empire. Of course, a comparison of tables all covering the same decade, such as 1901–1910, would not show results so much in favor of American conditions, but there can be no doubt that there is an actual advantage which is considerable. This advantage seems natural and there appears no reason why it can not be maintained. In our minds, no one thing would conduce more to this end than to identify as soon as possible the whole of the United States with the registration area. In fact, to have a single state— not to speak of over half of the union—in which no accurate record of deaths is required, should be regarded as a national disgrace.

MALES.

Age.	l_x.	d_x.	q_x.	$\overset{\circ}{e}_x$.	Age.	l_x.	d_x.	q_x.	$\overset{\circ}{e}_x$.
0	1000000	142420	.14243	48.34	50	576439	9079	.01575	20.59
1	857570	26310	3068	55.15	51	567360	9282	1636	19.94
2	831260	11579	1393	55.94	52	558078	9554	1712	19.25
3	819681	7180	876	55.70	53	548524	9956	1815	18.56
4	812501	5363	660	55.22	54	538568	10486	1947	17.86
5	807138	3971	.00492	54.27	55	528082	11063	.02095	17.22
6	803167	3438	428	53.93	56	517019	11736	2270	16.59
7	799729	2983	373	53.13	57	505283	12425	2459	15.97
8	796746	2605	327	52.33	58	492858	13002	2638	15.36
9	794141	2311	291	51.53	59	479856	13455	2804	14.75
10	791830	2122	.00268	50.66	60	466401	13908	.02982	14.16
11	789708	2006	254	49.79	61	452493	14308	3162	13.60
12	787702	1993	253	48.92	62	438185	14762	3369	13.04
13	785709	2059	262	48.03	63	423423	15379	3632	12.47
14	783650	2218	283	47.16	64	408044	16134	3954	11.89
15	781432	2657	.00340	46.34	65	391910	16860	.04302	11.36
16	778775	2998	385	45.46	66	375050	17612	4696	10.78
17	775777	3336	430	44.63	67	357438	18183	5087	10.36
18	772441	3646	472	43.86	68	339255	18377	5417	9.89
19	768795	3915	509	43.03	69	320878	18284	5698	9.43
20	764882	4184	.00547	42.25	70	302594	18141	.05995	8.97
21	760698	4465	587	41.48	71	284453	17869	6282	8.51
22	756233	4674	618	40.74	72	2665°4	17707	6642	8.05
23	751559	4780	636	39.96	73	248877	17810	7156	7.58
24	746779	4832	647	39.22	74	231067	18090	7829	7.12
25	741947	4786	.00645	38.48	75	212977	18254	.08571	6.69
26	737161	4909	666	37.74	76	194723	18360	9429	6.27
27	732252	5031	687	36.98	77	176363	18299	10376	5.87
28	727221	5156	709	36.24	78	158064	17978	11374	5.49
29	722065	5286	732	35.49	79	140086	17452	12458	5.13
30	716779	5405	.00754	34.75	80	122634	16973	.13840	4.79
31	711374	5791	814	34.01	81	105661	16615	15725	4.48
32	705583	5659	802	33.28	82	89046	15785	17726	4.22
33	699924	6723	833	32.55	83	73261	14065	19198	4.02
34	693201	6010	867	31.86	84	59196	11795	19925	3.86
35	687191	6192	.00901	31.14	85	47401	9099	.19196	3.70
36	680999	6374	936	30.41	86	38302	7786	20328	3.46
37	674625	6537	969	29.71	87	30516	66231	21705	3.21
38	668088	6661	997	28.98	88	23893	5595	23416	2.97
39	661427	6773	1024	28.28	89	18298	4682	25588	2.72
40	654654	6894	.01053	27.55	90	13616	3867	.28403	2.48
41	647760	7022	1084	26.85	91	9749	3026	31036	2.27
42	640738	7176	1120	26.13	92	6723	2286	34002	2.07
43	633562	7387	1166	25.42	93	4437	1656	37333	1.87
44	626175	7633	1219	24.72	94	2781	1142	41057	1.69
45	618542	7899	.01277	24.02	95	1639	741	.45205	1.52
46	610643	8189	1341	23.32	96	898	447	49807	1.36
47	602454	8458	1404	22.63	97	451	248	54893	1.21
48	593996	8684	1462	21.95	98	203	123	60493	1.07
49	585312	8873	1516	21.27	99	80	53	66638	.94
					100	27	20	.73356	.80
					101	7	6	80678	.64
					102	1	1	88635	.50
					103	0			

FEMALES.

Age.	l_x.	d_x.	q_x.	$\overset{\circ}{e}_x$.	Age.	l_x.	d_x.	q_x.	$\overset{\circ}{e}_x$.
0	1000000	116380	.11638	51.92	50	627304	8029	.01280	21.95
1	883620	24803	2807	57.69	51	619275	8348	1348	21.22
2	858817	9859	1148	58.34	52	610927	8706	1425	20.50
3	848958	8074	951	58.02	53	602221	9124	1515	19.79
4	840884	5205	619	57 57	54	593097	9626	1623	19.09
5	835679	3886	.00465	56.86	55	583471	10193	.01747	18.40
6	831793	3352	403	56.18	56	573278	10829	1889	17.71
7	828441	2908	351	55.41	57	562449	11513	2047	17.05
8	825533	2534	307	54.61	58	550936	12154	2206	16.39
9	822999	2255	274	53 76	59	538782	12731	2363	15.75
10	820744	2118	.00258	52.92	60	526051	13309	.02530	15.12
11	818626	1981	242	52.05	61	512742	13824	2696	14.50
12	816645	1935	237	51.18	62	498918	14389	2884	13.89
13	814710	1996	245	50.29	63	484529	15093	3115	13.29
14	812714	2137	263	49.42	64	469436	15919	3391	12.69
15	810577	2578	.00318	48.55	65	453517	16721	.03687	12.12
16	807999	2917	361	47.71	66	436796	17520	4011	11 57
17	805082	3228	401	46.88	67	419276	18251	4353	11.03
18	801854	3488	435	46.05	68	401025	18828	4695	10.51
19	798366	3696	463	45.26	69	382197	19270	5042	10.00
20	794670	3918	.00493	44.46	70	362927	19682	.05423	9.51
21	790752	4144	524	43.67	71	343245	20001	5827	9.03
22	786608	4318	549	42.91	72	323244	20248	6264	8.55
23	782290	4475	571	42.10	73	302996	20434	6744	8.09
24	777815	4574	588	41 39	74	282562	20554	7274	7.64
25	773241	4678	.00605	40 63	75	262008	20560	.07847	7.20
26	768563	4788	623	39.88	76	241448	20414	8455	6.77
27	763775	4881	639	39 12	77	221034	20253	9163	6.35
28	758894	4971	655	38.38	78	200781	20174	10048	5.93
29	753923	5051	670	37.62	79	180607	20158	11161	5.55
30	748872	5130	.00685	36.86	80	160449	20127	.12544	5.18
31	743742	5206	700	36.11	81	140322	20264	14441	4.85
32	738536	5288	716	35.37	82	120058	19732	16435	4.58
33	733248	5375	733	34.62	83	100326	17822	17764	4.39
34	727873	5466	751	33.88	84	82504	15054	18246	4.23
35	722407	5555	.00769	33.13	85	67450	11827	.17534	4.06
36	716852	5642	787	32.38	86	55623	10280	18481	3.81
37	711210	5718	804	31 63	87	45°43	8896	19620	3.57
38	705492	5778	819	30.88	88	36447	7665	21031	3.31
39	699714	5836	834	30.13	89	28782	6573	22838	3.06
40	693878	5898	.00850	29 38	90	22209	5619	.25300	2 82
41	687980	5979	869	28.63	91	16590	4547	27405	2.61
42	682001	6090	893	27.87	92	12043	3582	29740	2.40
43	675911	6252	925	27.13	93	8461	2735	32325	2.20
44	669659	6449	963	26.36	94	5726	2014	35180	2.02
45	663210	6665	.01005	25.63	95	3712	1423	38325	1.84
46	656545	6907	1052	24.88	96	2289	956	41780	1.68
47	649638	7166	1103	24.14	97	1333	607	45564	1.52
48	642472	7440	1158	23.41	98	726	361	49697	1.37
49	635032	7728	1217	22.67	99	365	198	54200	1.23
					100	167	99	.59092	1.10
					101	68	44	64393	.99
					102	24	17	70123	.88
					103	7	5	76301	.79
					104	2	2	82948	.50
					105	0			

MALES AND FEMALES, COMBINED.

Age.	l_x.	d_x.	q_x.	$\overset{o}{e}_x$.	Age.	l_x.	d_x.	q_x	$\overset{o}{e}_x$.
0	1000000	129630	.12963	50.08	50	601198	8615	.01433	21.25
1	870370	25580	2939	56.49	51	592583	8877	1498	20.53
2	844790	10687	1265	57.14	52	583706	9193	1575	19.84
3	834103	7590	910	56.88	53	574513	9600	1671	19.15
4	826513	5290	640	56.37	54	564913	10118	1791	18.48
5	821223	3934	.00479	55.77	55	554795	10691	.01927	17.80
6	817289	3400	416	55.05	56	544104	11345	2085	17.15
7	813889	2946	362	54.26	57	532759	12030	2258	16.50
8	810943	2571	317	53 45	58	520729	12633	2426	15 86
9	80·372	2288	283	52.64	59	508096	13144	2587	15.26
10	806084	2120	.00263	51 77	60	494952	13656	.02759	14.65
11	803964	1994	248	50.90	61	481296	14107	2931	14 06
12	801970	1965	245	50 01	62	467189	14614	3128	13 47
13	800005	2024	253	49.15	63	452575	15270	3374	12.86
14	797981	2178	273	48.27	64	437305	15765	3605	12 32
15	795803	2618	.00329	47 39	65	421540	16828	.03991	11.75
16	793185	2959	373	46 57	66	404712	17597	4348	11.21
17	790226	3287	416	45 74	67	387115	18241	4712	10.71
18	786939	3565	453	44.91	68	368874	18624	5049	10 20
19	783374	3799	485	44.15	69	350250	18787	5364	9.73
20	779575	4054	.00520	43 31	70	331463	18913	.05706	9.26
21	775521	4304	555	42.53	71	312550	18919	6053	8.76
22	771217	4504	584	41.81	72	293631	18948	6453	8.30
23	766713	4623	603	41.03	73	274683	19088	6949	7.84
24	762090	4702	617	40.29	74	255595	19292	7548	7.39
25	757388	4741	.00626	39.55	75	236303	19379	.08201	6.97
26	752647	4855	645	38.76	76	216924	19358	8924	6 54
27	747792	4965	664	38.02	77	197566	19243	9740	6.12
28	742827	5066	682	37.26	78	178323	19036	10675	5.75
29	737761	5179	702	36.52	79	159287	18754	11774	5.38
30	732582	5282	.00721	35.76	80	140533	18487	.13155	5.00
31	727300	5520	759	35.06	81	122046	18361	15044	4.70
32	721780	5486	760	34.29	82	103685	17666	17038	4 43
33	716294	5623	785	33.58	83	86019	15850	18426	4.25
34	710671	5764	811	32.81	84	70169	15339	19010	4.09
35	704907	5900	.00837	32.08	85	56830	10388	.18279	3.94
36	699007	6039	864	31.36	86	46442	8961	19295	3.72
37	692968	6160	889	30.63	87	37481	7692	20522	3.48
38	686808	6257	911	29.88	88	29789	6566	22042	3.25
39	680551	6350	933	29.15	89	23223	5568	23977	3.03
40	674201	6445	.00956	28.45	90	17655	4686	.26555	2.81
41	667756	6551	981	27.69	91	12969	3642	28851	2.65
42	661205	6691	1012	26.97	92	9327	2030	31416	2.50
43	654514	6879	1051	26.22	93	7297	2501	34274	2.06
44	647635	7105	1097	25.50	94	4796	1796	37449	1.88
45	640530	7347	.01147	24.77	95	3000	1229	.40965	1.71
46	633183	7611	1202	24.08	96	1771	794	44845	1.54
47	625572	7882	1260	23.35	97	977	480	49114	1.39
48	617690	8129	1316	22.64	98	497	267	53796	1.25
49	609561	8363	1372	21.93	99	230	135	58913	1.11
					100	95	61	.64491	98
					101	34	24	70553	.85
					102	10	8	77122	.70
					103	2	2	84223	.50
					104	0			

DEATH-RATES.*

Age.	Males.			Females.			Males and Females.	
	English.	German.	American.	English.	German.	American.	German.	American.
0.....	.17186	.23386	.14243	.14066	.19862	.11638	.21670	.12963
10.....	.00214	.00304	.00268	.00231	.00322	.00258	.00313	.00263
20.....	.00457	.00507	.00547	.00414	.00459	.00493	.00518	.00520
30.....	.00671	.00655	.00754	.00618	.00696	.00685	.00676	.00721
40.....	.01190	.01094	.01053	.00995	.00901	.00850	.00995	.00956
50.....	.01936	.01860	.01575	.01495	.01288	.01280	.01560	.01433
60.....	.03596	.03395	.02982	.02928	.02751	.02530	.03051	.02759
70.....	.07212	.07342	.05995	.06243	.06786	.05423	.07038	.05706
80.....	.15200	.16384	.13840	.13626	.15575	.12544	.15933	.13155
90.....	.29186	.33597	.28403	.26378	.30239	.25300	.31551	.26555

EXPECTATIONS OF LIFE.*

Age.	Males.			Females.			Males and Females.	
	English.	German.	American.	English.	German.	American.	German.	American.
0.....	44.13	40.56	48.34	47.77	43.97	51.92	42.23	50.08
1.....	52.22	51.85	55.15	54.53	53.79	57.69	52.83	56.49
10.....	49 63	49.66	50.66	51.97	51.71	52.92	50.70	51.77
20.....	41.02	41.23	42.25	43.44	43 37	44.46	42.32	43.31
30.....	33.07	33.46	34.75	35.39	35 63	36 86	34.56	35.76
40.....	25.64	25.89	27.55	27.82	28.15	29.38	27.04	28.45
50.....	18.90	19 00	20.59	20.64	20.58	21.95	19 82	21.25
60.....	12.93	12.82	14.16	14.10	13.60	15.12	13.24	14.65
70.....	8 05	7.77	8 97	8.78	8.11	9.51	7.95	9.26
80.....	4.62	4.24	4.79	5.05	4.49	5.18	4.38	5.00
90.....	2.58	2.32	2.48	2.87	2.66	2.82	2.52	2.81

* The English and German tables are based upon the decade 1891–1900, while the American table is based upon the decade 1901–1910.